FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
743-P-3-USA	
U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	
10/088924	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/AU00/01147	20 September 2000	20 September 1999

TITLE OF INVENTION
ANIMAL CARCASE ANALYSIS

APPLICANT(S) FOR DO/EO/US
ALAN BENN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/938924	PCT/AU00/01147	743-P-3-USA

24. The following fees are submitted:		CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :			
☒ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1040.00		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	$890.00		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$740.00		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$710.00		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =		$1,040.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).		$0.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	15 - 20 =	0	x $18.00	$0.00	
Independent claims	2 - 3 =	0	x $84.00	$0.00	
Multiple Dependent Claims **(check if applicable)**.			☐	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$1,040.00	
☒ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				$520.00	
SUBTOTAL =				$520.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).			+	$0.00	
TOTAL NATIONAL FEE =				$520.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **(check if applicable).** ☒				$80.00	
TOTAL FEES ENCLOSED =				$600.00	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$600.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

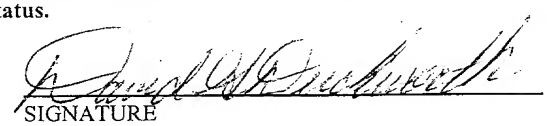
c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. _____ A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

David G. Duckworth
DRUMMOND & DUCKWORTH
5000 Birch Street, Suite 440, East Tower
Newport Beach, CA 92660
(949) 724-1255



SIGNATURE

David G. Duckworth
NAME

39,516
REGISTRATION NUMBER

March 19, 2002
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Alan Benn	Examiner:	
Serial No:		Art Unit:	
Filed:			
Title:	ANIMAL CARCASE ANALYSIS	Date: March 19, 2002	

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231

Sir:

Please amend the claims of the above-identified application in accordance with the Clean Version and Version With Markings attached herewith.

REMARKS

The above-identified application is a National Stage application derived from International Application Serial No. PCT/AU00/01147 filed on September 20, 2000, now published on March 29, 2001, International Publication No. WO 01/22081, which derives from Australian Patent Application Serial No. PQ2969 filed on September 20, 1999. A chain

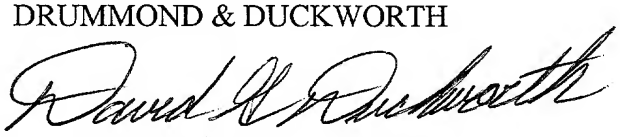
of codependency exists such that the effective filing date of the instant application is September 20, 1999, the filing date of the first of these applications.

Claims 1 - 15 are pending in the instant application. Entry of the amendments is respectfully requested. No new matter is added. The amendments are made merely to better comply with U.S. Patent Office requirements.

The Examiner's attention to the present application is greatly appreciated. It is believed that the claims in this case are in condition for allowance and notice thereof is respectfully solicited. If there are any remaining issues that need to be resolved, it is respectfully requested that a telephone call be placed to the undersigned.

Respectfully submitted,

DRUMMOND & DUCKWORTH



David G. Duckworth
Registration No. 39,516
Attorney for Applicant
Telephone: (949) 724-1255

VERSION WITH MARKINGS TO SHOW CHANGES MADE

AMENDMENT OF THE CLAIMS

Please amend Claims 5, 6, 8, 11, and 12 as follows:

5. A process as claimed in [any one of the preceding claims] claim 1 wherein the image data relates to an ovine animal carcase and wherein the process includes the further step of processing the image data to identify the tail of the animal carcase, the identification of the tail comprising identification of lateral edges of the tail which are delineated in the captured image by generally linear darker areas extending lengthwise relative to the spine of the carcase, the process including the further step of determining the width of the tail between the lateral edges, and wherein the step of deriving at least one characterising parameter includes deriving a parameter related to the predicted yield of the carcase using the width of the tail as a variable in a carcase yield predictive equation.

6. A process as claimed in [any one of the preceding claims] claim 1 wherein the step of processing colour data comprises measuring the average RGB values representing red, green and blue colour components within said at least one predetermined selected surface area.

8. A process as claimed in claim 6 [or 7] wherein the image data relates to an ovine animal carcase and wherein there are multiple predetermined selected surface areas of the carcase for which colour data is processed, the multiple predetermined surface areas comprising areas which are automatically positioned relative to the predetermined anatomical points and which generally coincide with the chump, the loin and the shoulder areas of the carcase used in standarised manual carcase grading systems for evaluating carcase fatness.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

11. A process as claimed in claim 6 [or 7] wherein the step of processing the colour data includes analysing the rate of change of RGB values in a line profile across the image of the carcase transverse to the longitudinal line of the spine and wherein the step of deriving a characterising parameter includes solving a predictive equation for a measure of fatness of the carcase in which the rate of change of the RGB values is a variable in that predictive equation.

12. A process as claimed in [any one of the claims 6 to 11] claim 6 wherein the step of deriving a characterising parameter related to fatness of the carcase includes performing statistical analyses of multiple carcases to provide correlations between average RGB values of said at least one [predetermined selected surface area and carcase fatness and using these correlations to develop a predictive equation for carcase fatness in which the average RGB values are variables in the predictive equation.

CLEAN VERSION

CLAIMS

1. A process for analysing an animal carcase which includes the steps of:

providing an image capture means for capturing image data relating to an animal carcase,

presenting an animal carcase to the image capture means, the carcase being positioned with the dorsal view of the carcase presented directly to the image capture means,

capturing image data for the dorsal view of the carcase by the image capture means,

processing the image data so as to automatically identify predetermined anatomical points of the carcase,

deriving dimensional measurements for the carcase by using the anatomical points identified, and

deriving at least one characterising parameter related to fatness of the carcase by processing colour data included in the captured image data in conjunction with the derived dimensional measurements, the colour data processed being the colour data for at least one predetermined selected surface area of the carcase known or determined to have a significant correlation to the characterising parameter related to fatness.

2. A process as claimed in claim 1wherein the predetermined anatomical points of the carcase includes points selected from a head point, two elbows, two hips, two leg outer points, and a groin point.

CLEAN VERSION

3. A process as claimed in claim 2 wherein the dimensional measurements derived for the carcase include dimensional measurements selected from:

linear distances between selected ones of said anatomical points,

areas enclosed by an outline around the perimeter of the image of the carcase,

areas enclosed by portions of the outline around the perimeter of the carcase and predetermined distance measurement lines between selected anatomical points,

widths and areas of the hind legs of the carcase or of predetermined portions thereof, and

angles defined between predetermined distance measurement lines between selected anatomical points, including the groin angle between lines drawn from the groin point to the hind legs.

4. A process as claimed in claim 3 wherein the step of deriving dimensional measurements includes converting dimensional measurements derived from the image of the carcase to true distances for the particular carcase by using geometrical formulae or transformations to derive true dimensional measurements compensated for perspective or foreshortening effects of the captured dorsal view of the carcase, whereby dimensional descriptors used in standardised manual carcase grading systems are determined for the particular carcase.

CLEAN VERSION

5. A process as claimed in claim 1 wherein the image data relates to an ovine animal carcase and wherein the process includes the further step of processing the image data to identify the tail of the animal carcase, the identification of the tail comprising identification of lateral edges of the tail which are delineated in the captured image by generally linear darker areas extending lengthwise relative to the spine of the carcase, the process including the further step of determining the width of the tail between the lateral edges, and wherein the step of deriving at least one characterising parameter includes deriving a parameter related to the predicted yield of the carcase using the width of the tail as a variable in a carcase yield predictive equation.

6. A process as claimed in claim 1 wherein the step of processing colour data comprises measuring the average RGB values representing red, green and blue colour components within said at least one predetermined selected surface area.

7. A process as claimed in claim 6 wherein the RGB values are intensity normalised colour values substantially independent of light intensity.

8. A process as claimed in claim 6 wherein the image data relates to an ovine animal carcase and wherein there are multiple predetermined selected surface areas of the carcase for which colour data is processed, the multiple predetermined surface areas comprising areas which are automatically positioned relative to the predetermined anatomical points and which generally coincide with the chump, the loin and the shoulder areas of the carcase used in standarised manual carcase grading systems for evaluating carcase fatness.

CLEAN VERSION

9. A process as claimed in claim 8 wherein the multiple surface areas are arranged in respective pairs located symmetrically on opposite sides of the spine of the carcase, the processing of the coloured data including averaging of colour values for each laterally spaced pair of surface areas.

10. A process as claimed in claim 9 wherein the processing of colour data for the respective pairs of surface areas includes comparing the average colour values of each surface area with its respective counterpart of the respective pair and generating an alarm or error signal if the average colour values for the two members of any pair vary significant from each other.

11. A process as claimed in claim 6 wherein the step of processing the colour data includes analysing the rate of change of RGB values in a line profile across the image of the carcase transverse to the longitudinal line of the spine and wherein the step of deriving a characterising parameter includes solving a predictive equation for a measure of fatness of the carcase in which the rate of change of the RGB values is a variable in that predictive equation.

12. A process as claimed in claim 6 wherein the step of deriving a characterising parameter related to fatness of the carcase includes performing statistical analyses of multiple carcases to provide correlations between average RGB values of said at least one [predetermined selected surface area and carcase fatness and using these correlations to develop a predictive equation for carcase fatness in which the average RGB values are variables in the predictive equation.

13. A process as claimed in claim 12 wherein the parameter related to fatness of the carcase is selected from lean meat yield and fat thickness.

CLEAN VERSION

14. An apparatus for analysing an animal carcase, the apparatus including:

image capture means for capturing image data relating to an animal carcase, the image capture means including a colour camera located at an image capture station where an animal carcase is presented with the dorsal view of the carcase presented directly into the camera, the image capture means also including an associated system for converting the camera video signals to digital colour data signals, and

processing means operative to automatically identify predetermined anatomical points of the carcase by processing the digital colour data signals, the processing means further being operative to derive dimensional measurements for the carcase using the anatomical points identified, the processing means further being operative to derive at least one characterising parameter related to fatness of the carcase by processing colour data included in the captured image data in conjunction with the derived dimensional measurements, the colour data processed being the colour data for at least one predetermined selected surface area of the carcase known or determined to have a significant correlation to the characterising parameter related to fatness.

15. Apparatus as claimed in claim 14 wherein the image capture means includes lighting means for illuminating the regions of the carcase in the region of the spine of the carcase where said at least one predetermined selected surface area of the carcase are located, the lighting means being positioned adjacent or distributed around the camera of the image capture means and directed generally towards the dorsal aspect of the carcase presented.

ANIMAL CARCASE ANALYSIS

FIELD OF THE INVENTION

This invention relates to methods and apparatus for analysing animal carcases, particularly for ovine carcase analyses.

BACKGROUND

In the meat industry, specialist trained and skilled operators are employed, in abattoirs for example, in order to inspect each animal carcase and to provide estimates or gradings of various parameters, such as the predicted saleable meat yield of each carcase. Such predictions of meat yield and gradings are very important for fixing a fair value for the carcase and for determining uses to which the carcase and meat cuts will be destined. Obviously it is very important for the meat industry generally including producers, processors and consumers that such operators are consistent both within a particular abattoir or processing facility and between different facilities at different places and different times.

In the case of ovine carcases, particularly sheep carcases, the analyses commonly used include both quantitative and qualitative measurements or assessments such as dimensional measurements, yield, particularly "lean meat yield", and fat depths.

There have been proposed and developed automated systems for image capture and colour analysis for automating beef carcase yield predictions or gradings, or at least for providing some objective replacement or supplement to human operators. However, such automated analysis and yield predicting systems for beef have not been applicable to sheep carcases both in their physical construction and arrangement, and also in the analyses performed and data output.

OBJECT OF THE INVENTION

It is an object of the present invention to provide a method and apparatus for analysis of animal carcases, particularly ovine animal carcases, so as to automatically derive quantitative and/or qualitative descriptors or characteristics of the carcases.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a process for analysing an animal carcase which includes the steps of:

providing an image capture means for capturing image data relating to an animal carcase,

presenting an animal carcase to the image capture means, the carcase being positioned with the dorsal view of the carcase presented directly to the image capture means,

capturing image data for the dorsal view of the carcase by the image capture means,

processing the image data so as to automatically identify predetermined anatomical points of the carcase,

deriving dimensional measurements for the carcase by using the anatomical points identified, and

deriving at least one characterising parameter related to fatness of the carcase by processing colour data included in the captured image data in conjunction with the derived dimensional measurements, the colour data processed being the colour data for at least one predetermined selected surface area of the carcase known or determined to have a significant correlation to the characterising parameter related to fatness.

According to another aspect of the present invention there is provided an apparatus for analysing an animal carcase, the apparatus including:

image capture means for capturing image data relating to an animal carcase, the image capture means including a colour camera located at an image capture station where an animal carcase is presented with the dorsal view of the carcase presented directly into the camera, the image capture means also including an associated system for converting the camera video signals to digital colour data signals, and

processing means operative to automatically identify predetermined anatomical points of the carcase by processing the digital colour data signals, the processing means further being operative to derive dimensional measurements for the carcase using the anatomical points identified, the processing means further being operative to derive at least one characterising parameter related to fatness of the carcase by processing colour data included in the captured image data in conjunction with the derived dimensional measurements, the colour data processed being the colour data for at least one predetermined selected surface area of the carcase known or determined to have a significant correlation to the characterising parameter related to fatness.

It will be convenient to describe the invention in relation to analysis of a sheep carcase but it is to be understood that other animal carcases can be used with the present invention, particularly ovine carcases including, for example, goat carcases. The particular sheep carcase system developed and to be described herein can be generally similar to systems developed and published for analysing beef carcases, both in terms of equipment and software. Therefore reference may be made to such known systems for general features of the sheep carcase system. For example, patent specification WO 91/14180 describes and illustrates a beef carcase analysis system providing principal components and systems required for an automated analysis system.

As sheep carcases are typically less than half the length of beef carcases, however, the appropriate mechanical components, which generally means anything associated with the carcase imaging station can be scaled down. Individual components such as the camera and a camera enclosure (which preferably provides both physical protection and a controlled environment for the camera can be substantially the same as in the beef carcase systems.

The preferred apparatus has the image capture means which includes lighting means for illuminating the regions of the carcase in the region of the spine of the carcase where the predetermined selected surface areas of the carcase are located, the lighting means being positioned adjacent or distributed around the camera of the image capture means and directed generally towards the dorsal aspect of the carcase presented.

With regard to lighting of the sheep carcases as they are presented to the image capture means at the image capture station, it may be satisfactory to provide a single light source, e.g. adjacent to the camera, to illuminate each sheep carcase presented for image capture. A single light source may be suitable since wider or more uniform illumination may not be necessary to identify the anatomical points and since colour data used in the carcase analysis operation preferably relates to selected areas relatively close to the spine so that illumination from a single light source adjacent the camera may provide sufficient illumination for such areas. However it is also possible to use distributed lighting to give a flatter and more uniform light distribution.

Unlike beef carcases which are viewed as split sides with the lateral aspect presented to the camera, sheep carcases as mentioned earlier are imaged unsplit according to the present invention and are presented with the dorsal view, i.e. the back of the carcase, presented directly to the camera.

The analysis operations for sheep carcases are completely different to those for beef carcases, resulting in a completely different set of carcase measurements and descriptors and, of course, the derived outputs from the system are completely different and are appropriate to the description of sheep carcases.

The image capture station is designed to provide an environment to enable accurate, repeatable positioning, illumination and image capture of the sheep carcases. It is designed so that carcases moving on the normal abattoir carcase transport equipment progress unimpeded through an enclosure or booth and the images are automatically acquired. The carcase transport equipment preferably includes alignment devices operative to ensure the sheep carcases are positioned with the dorsal view presented directly at the camera. The enclosure also includes sensors to detect the presence of the carcases and control image capture.

The booth preferably includes its own lighting system to control the illumination of the carcase and the booth preferably excludes all external lighting so that external lighting does not illuminate the carcase. The lighting arrangement may use light source(s) positioned adjacent or distributed around the camera to illuminate the regions of the carcase which are useful for indicating carcase fatness and to help enhance the discrimination of fat and lean regions. Also included in the field of view are standard coloured tiles which are used to calibrate colour measurements by compensating for any changes in illumination or camera characteristics. The calibration procedures and apparatus can be substantially the same as used for beef carcase systems and, in particular, can be substantially as described in detail and illustrated in patent specification WO 98/39627.

For capturing the image data for each sheep carcase, the system preferably uses a video camera. The video camera is preferably enclosed in a temperature controlled

enclosure and generates standard format video signals of the carcases which are provided to the controlling computer system. The camera and its enclosure can be substantially the same as used for a beef carcase system and may be for example as described in Australian patent specification No. PCT/AU00/00829, filed 10 July 2000.

The image capture system including the camera and associated computer system may include a special interface card, known as a "frame grabber" to convert the camera video signals into a digital format. The image data will therefore comprise positional and colour data for each pixel in an array of pixels representing the imaged area. Once in a digital format, the sheep analysis software running on the computer system can process the image to detect features and make quantitative measurements.

The quantitative measurements can be generally grouped into two categories:

(a) dimensional measurements, e.g. lengths, areas (including lengths and/or areas of the entire carcase or of particular components of the carcase such as the legs), ratios, angles, etc.,

(b) colour measurements - for example each part of the captured image may be converted into three values, i.e. the RGB values representing the intensity of red, green and blue light coming from each respective part of the carcase. The absolute and relative values of these RGB numbers give a quantitative representation of the colour of the parts of the carcase. If desired, as described in patent specification No. PCT/AU00/00830 filed 10 July 2000, the RGB values may be processed to provide intensity normalised colour values, i.e. colour values substantially independent of light intensity, so that subsequent analyses using these intensity normalised colour values are not

subject to unwanted variations and inaccuracies due to differing light intensities of the illuminating light source(s).

The computer system would in practice also provide an operator interface for the overall system to enable control, configuration and display of results to an operator. Operator input can be via conventional peripheral devices such as via a computer mouse, keyboard, scanner, or via electronic links to other abattoir computer systems.

BRIEF DESCRIPTION OF THE DRAWINGS

To describe and illustrate the analysis procedures reference will be made to the accompanying drawings in which:

Fig. 1 shows a captured image of a sheep carcase suspended by the hind legs, e.g. from an overhead rail in a conventional transport system of an abattoir, the carcase having been presented to the camera with the dorsal view directly facing the camera.

Fig. 2 is a depiction of the image of Figure 1 having been analysed to identify and trace the carcase outline, to identify particular anatomical points, and to derive some dimensions,

Fig. 3 is a similar view showing predetermined areas of the carcase identified for colour based analyses, and

Fig. 4 is a flow chart showing the steps in the preferred process according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

As shown in the drawings, the captured image includes the image of the carcase 10 against a background 11. The background may comprise the image of a background panel such as a non-reflective black panel located behind the carcase in the image capture booth. The illuminated carcase overlying the black background 11 will enable ready processing of

the image data to identify the outline 15 of the carcase image, e.g. by scanning inwardly from the edges 12 of the image through pixels representing the background 11 and identifying the boundary 15 by the abrupt change in colour and/or light intensity.

It may be possible for all dimensional measurements to be used in the system of the present invention to be measurements relating to the outline, i.e. with no features internal to this outline being located, identified and measured. However, if desired, the system may be programmed and operated to analyse captured image data in the area of the rump 16 of the animal so as to identify the tail 17. As seen in the drawings, the lateral edges of the tail 17 are delineated in the captured image by generally linear darker areas 18 extending lengthwise along each side of the tail so that these linear darker areas 18 can be identified by the analysis algorithms and hence the width of the tail 17 can be determined for use in yield prediction as mentioned later.

The main aims of the dimensional analysis are to find shape descriptors related to conformation/muscle score and also to locate features of the carcase to enable determination of the positions of predetermined areas for colour measurements and analysis.

Fig. 2 shows the results from locating the carcase outline 15 and the overlaid lines 20 illustrate basic dimensional measurements. All measurements are made with relation to detected "anatomical points". These are points on the outline 15 which are readily detected by features on the outline (e.g. sharp corners) and which are associated with particular parts of the anatomy. Examples are shown in Fig. 2 as the head point 21, "elbows" 22, hips 23, leg outer points 24, and the groin point 25. As well as simple linear distances as shown by the lines in Fig. 2, other measurements made may include: measurements of areas enclosed by the outline and various distance measurement lines 20; widths and areas on the hind legs 13 or portions thereof; and angles between distance measurement lines, e.g. the groin angle

27 between the lines from the groin point 25 to the hind legs 13. Another measurement mentioned earlier is the width of the tail 17 which has been found to have a significant predictive correlation to the yield of the carcase and which can therefore be used as a variable in a yield predictive equation.

The system may be calibrated so that dimensional measurements or distances 20 in the image can be converted to true distances/areas on the carcase by taking into account perspective or foreshortening effects of the dorsal view used. These and other dimensional measurements can been mathematically related to carcase descriptions provided by expert graders and also other quantitative measurements e.g. lean meat yield and fat depths, so that the measurements can be used to predict these other carcase descriptors in standardised manual carcase grading systems. Purely dimensional descriptors formerly provided by expert graders can be readily calculated from the dimensional data derived from the image analysis by relatively simple geometrical formulae or transformations. However, in deriving descriptors of the carcase such as lean meat yield, characteristics of the carcase in addition to purely dimensional characteristics are relevant and statistical methodologies can be used to derive predictive equations utilising both dimensional data as well as colour related data shown to have good predictive relationships or correlations with the descriptor being derived. An example of a purely dimensional characteristic having been determined to have good predictive correlations with yield is the width or thickness of the tail 17. Hence a derived measure of the width of the tail can be incorporated in a yield predictive equation.

With regard to utilising colour information in the captured image data to derive descriptors of the sheep carcase, the simplest method of extracting colour information from the carcase image is to measure the average RGB values within a defined region. Fig. 3

shows rectangular areas superimposed on the carcase image. These rectangles have been automatically positioned relative to the anatomical features found in the dimensional analysis (Fig. 2) and are designed to coincide with chump 30, loin 31 and shoulder areas 32 that carcase grading experts use for evaluating carcase fatness. As illustrated, these areas 30-32 can be in respective pairs located symmetrically on opposite sides of the spine - enabling averaging of colour values for each laterally spaced pair, or possibly alarm or error signal generation if the average colour values for the two members of any pair vary significantly from each other, enabling manual intervention to identify the cause and correct for possible misleading output descriptors.

Relationships have been found by statistical analyses, e.g. multiple regression analyses, of multiple carcases to provide correlations between average RGB values and carcase fatness. Alternative a methods of using the RGB values to predict fatness may also be developed, e.g. analysing the rate of change of RGB values in a line profile across the carcase.

By discovering such relationships and providing the correlations to develop predictive equations, the present invention can provide a carcase analysis process and apparatus which automatically determines and outputs descriptors of the carcase, useful for example for grading and valuing the carcases. As mentioned earlier, dimensional descriptors are relatively easily derived and output once the outline and key anatomical points have been determined from the captured carcase images. Other carcase descriptors such as lean meat yield and fat thickness are correlated not only to dimensional characteristics but also to colour characteristics and therefore the predictive equations for such descriptors can be derived by statistical techniques using both dimensional and colour related parameters in the equations.

Fig. 4 illustrates process steps used in the processes according to the preferred embodiments of the present invention for image capture and analysis to provide characterising parameters for carcases. The steps can be readily understood by reference to the preceding description.

It will be seen from the preceding description that the present invention provides a useful process and apparatus for animal carcase analysis, particularly for ovine animal carcase analysis enabling at least partially automated analysis and output of useful carcase descriptors.

CLAIMS

1. A process for analysing an animal carcase which includes the steps of:

providing an image capture means for capturing image data relating to an animal carcase,

presenting an animal carcase to the image capture means, the carcase being positioned with the dorsal view of the carcase presented directly to the image capture means,

capturing image data for the dorsal view of the carcase by the image capture means,

processing the image data so as to automatically identify predetermined anatomical points of the carcase,

deriving dimensional measurements for the carcase by using the anatomical points identified, and

deriving at least one characterising parameter related to fatness of the carcase by processing colour data included in the captured image data in conjunction with the derived dimensional measurements, the colour data processed being the colour data for at least one predetermined selected surface area of the carcase known or determined to have a significant correlation to the characterising parameter related to fatness.

2. A process as claimed in claim 1 wherein the predetermined anatomical points of the carcase includes points selected from a head point, two elbows, two hips, two leg outer points, and a groin point.

3. A process as claimed in claim 2 wherein the dimensional measurements derived for the carcase include dimensional measurements selected from:

linear distances between selected ones of said anatomical points,

areas enclosed by an outline around the perimeter of the image of the carcase,

areas enclosed by portions of the outline around the perimeter of the carcase and predetermined distance measurement lines between selected anatomical points,

widths and areas of the hind legs of the carcase or of predetermined portions thereof, and

angles defined between predetermined distance measurement lines between selected anatomical points, including the groin angle between lines drawn from the groin point to the hind legs.

4. A process as claimed in claim 3 wherein the step of deriving dimensional measurements includes converting dimensional measurements derived from the image of the carcase to true distances for the particular carcase by using geometrical formulae or transformations to derive true dimensional measurements compensated for perspective or foreshortening effects of the captured dorsal view of the carcase, whereby dimensional descriptors used in standardised manual carcase grading systems are determined for the particular carcase.

5. A process as claimed in any one of the preceding claims wherein the image data relates to an ovine animal carcase and wherein the process includes the further step of processing the image data to identify the tail of the animal carcase, the identification of the tail comprising identification of lateral edges of the tail which are delineated in the captured image by generally linear darker areas extending lengthwise relative to the spine of the carcase, the process including the further step of determining the width of the tail between the lateral edges, and wherein the step of deriving at least one characterising parameter includes deriving a parameter related to the predicted yield of the carcase using the width of the tail as a variable in a carcase yield predictive equation.

6. A process as claimed in any one of the preceding claims wherein the step of processing colour data comprises measuring the average RGB values representing red, green and blue colour components within said at least one predetermined selected surface area.

7. A process as claimed in claim 6 wherein the RGB values are intensity normalised colour values substantially independent of light intensity.

8. A process as claimed in claim 6 or 7 wherein the image data relates to an ovine animal carcase and wherein there are multiple predetermined selected surface areas of the carcase for which colour data is processed, the multiple predetermined surface areas comprising areas which are automatically positioned relative to the predetermined anatomical points and which generally coincide with the chump, the loin and the shoulder areas of the carcase used in standardised manual carcase grading systems for evaluating carcase fatness.

9. A process as claimed in claim 8 wherein the multiple surface areas are arranged in respective pairs located symmetrically on opposite sides of the spine of the carcase, the processing of the coloured data including averaging of colour values for each laterally spaced pair of surface areas.

10. A process as claimed in claim 9 wherein the processing of colour data for the respective pairs of surface areas includes comparing the average colour values of each surface area with its respective counterpart of the respective pair and generating an alarm or error signal if the average colour values for the two members of any pair vary significant from each other.

11. A process as claimed in claim 6 or 7 wherein the step of processing the colour data includes analysing the rate of change of RGB values in a line profile across the image of the

carcase transverse to the longitudinal line of the spine and wherein the step of deriving a characterising parameter includes solving a predictive equation for a measure of fatness of the carcase in which the rate of change of the RGB values is a variable in that predictive equation.

12. A process as claimed in any one of claims 6 to 11 wherein the step of deriving a characterising parameter related to fatness of the carcase includes performing statistical analyses of multiple carcases to provide correlations between average RGB values of said at least one [predetermined selected surface area and carcase fatness and using these correlations to develop a predictive equation for carcase fatness in which the average RGB values are variables in the predictive equation.

13. A process as claimed in claim 12 wherein the parameter related to fatness of the carcase is selected from lean meat yield and fat thickness.

14. An apparatus for analysing an animal carcase, the apparatus including:

image capture means for capturing image data relating to an animal carcase, the image capture means including a colour camera located at an image capture station where an animal carcase is presented with the dorsal view of the carcase presented directly into the camera, the image capture means also including an associated system for converting the camera video signals to digital colour data signals, and

processing means operative to automatically identify predetermined anatomical points of the carcase by processing the digital colour data signals, the processing means further being operative to derive dimensional measurements for the carcase using the anatomical points identified, the processing means further being operative to derive at least one characterising parameter related to fatness of the carcase by processing colour data included in the captured image data in conjunction with the derived dimensional measurements, the

colour data processed being the colour data for at least one predetermined selected surface area of the carcase known or determined to have a significant correlation to the characterising parameter related to fatness.

15. Apparatus as claimed in claim 14 wherein the image capture means includes lighting means for illuminating the regions of the carcase in the region of the spine of the carcase where said at least one predetermined selected surface area of the carcase are located, the lighting means being positioned adjacent or distributed around the camera of the image capture means and directed generally towards the dorsal aspect of the carcase presented.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 March 2001 (29.03.2001)

PCT

(10) International Publication Number
WO 01/22081 A1

(51) International Patent Classification[7]: G01N 33/12

(21) International Application Number: PCT/AU00/01147

(22) International Filing Date:
20 September 2000 (20.09.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PQ 2969 20 September 1999 (20.09.1999) AU

(71) Applicant *(for all designated States except US)*: **RMS RESEARCH MANAGEMENT SYSTEMS INC** [CA/CA]; #1, 4216 - 10th Street, Calgary, Alberta T2E 6K3 (CA).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **BENN, Alan** [GB/AU]; 6 Warnes Street, Maylands, Western Australia 6051 (AU).

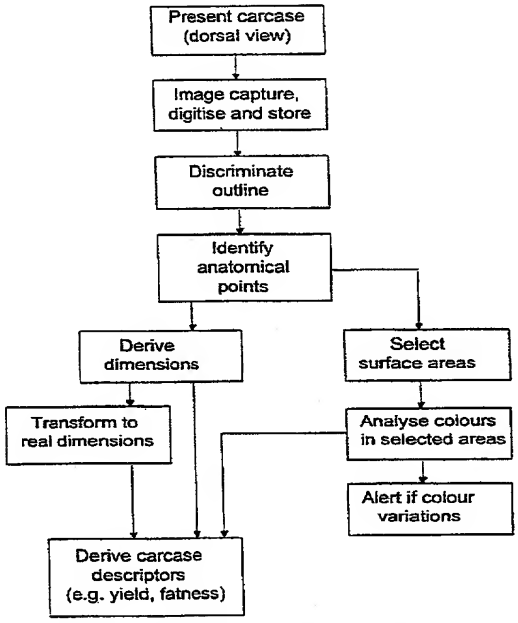
(74) Agent: **GRANT, Michael, John**; Patent Attorney Services, 26 Ellingworth Parade, Box Hill, Victoria 3128 (AU).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian

[Continued on next page]

(54) Title: ANIMAL CARCASE ANALYSIS



(57) Abstract: The process for analysing an ovine animal carcase comprises capturing an image of a dorsal view to generate colour image data for the carcase (10). Predetermined anatomical points (21 - 24) of the carcase are identified to then derive dimensional measurements for the carcase. Also characterising parameters such as yield and fat depth of the carcase are derived by processing colour data included in the captured image data in conjunction with the derived dimensional measurements. The colour data processed are the colour data for predetermined selected surface areas, especially the chump, the loin and the shoulder areas (30 - 32) of the carcase (10) known or determined to have a significant correlation to the characterising parameter related to fatness. Desirably the tail (17) of the animal carcase is identified and its width determined since this is useful as a variable in a carcase yield predictive equation. The colour data comprises average RGB values representing red, green and blue colour components which are intensity normalised colour values.

WO 01/22081 A1

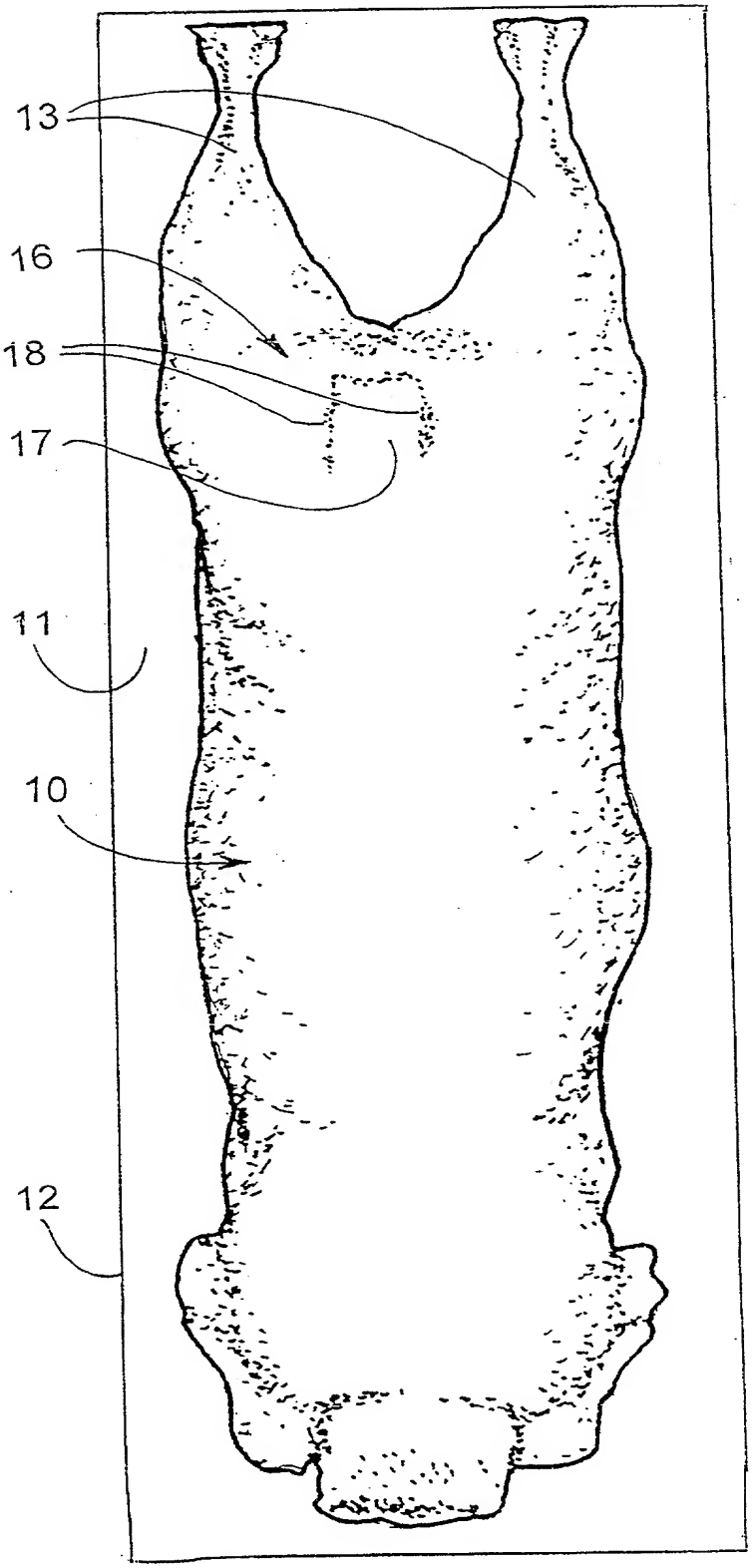


Fig. 1

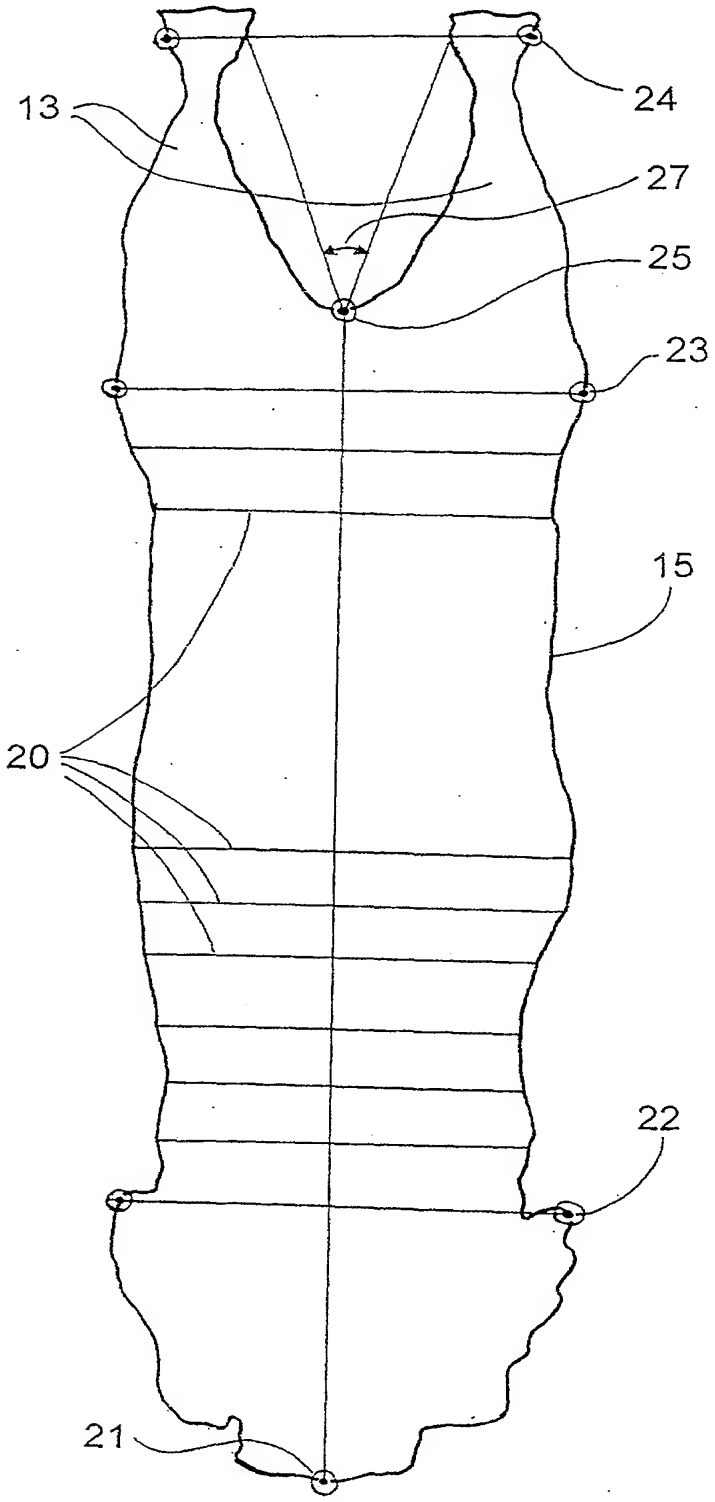


Fig. 2

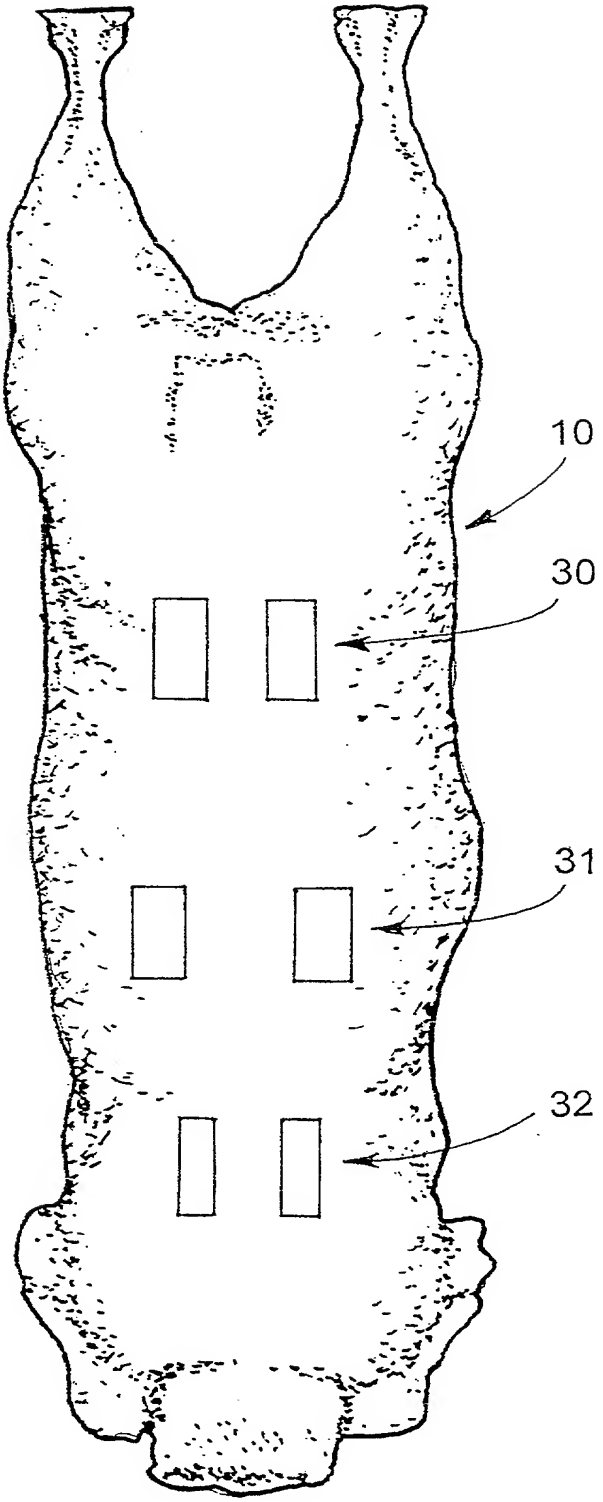


Fig. 3

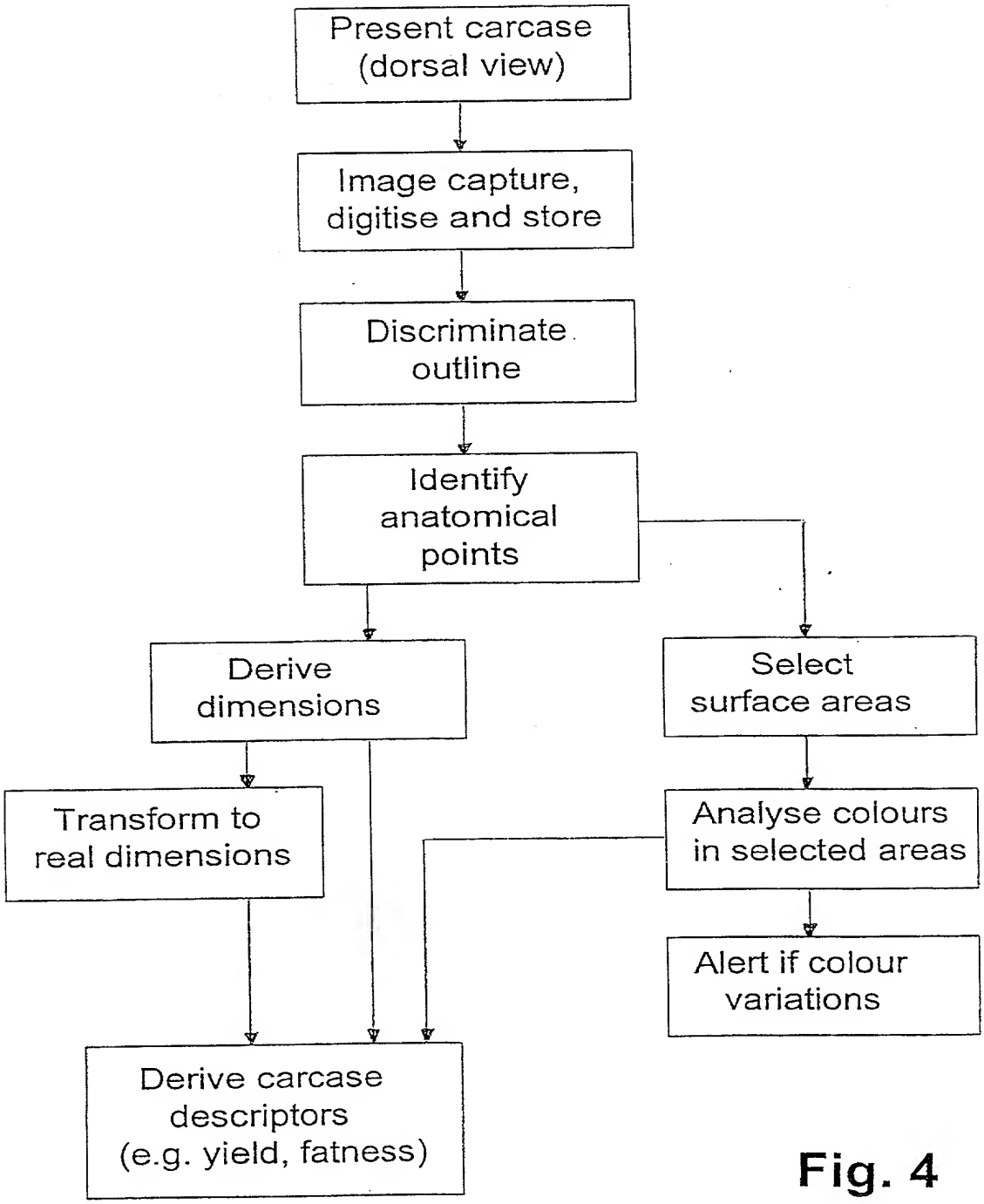

Present carcase (dorsal view)
Image capture, digitise and store
Discriminate outline
Identify anatomical points
Derive dimensions
Select surface areas
Transform to real dimensions
Analyse colours in selected areas
Alert if colour variations
Derive carcase descriptors (e.g. yield, fatness)

Fig. 4

Please type a plus sign (+) inside this box → [+]

PTO/SB/01 (12-97)
Approved for use through 9/30/00. OMB 0651-0032
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	
First Named Inventor	ALAN BENN
COMPLETE IF KNOWN	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ANIMAL CARCASE ANALYSIS

(Title of the Invention)

the specification of which
☐ is attached hereto
OR
☒ was filed on (MM/DD/YYYY) 09/20/2000 as United States Application Number or PCT International Application Number PCT/AU00/01147 and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
PQ 2969	AUSTRALIA	09/20/1999	☐	☐	☒
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)

☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

Please type a plus sign (+) inside this box → [+]

PTO/SB/01 (12-97)
Approved for use through 9/30/00. OMB 0651-0032
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number *(if applicable)*

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☐ Customer Number [ ] → *Place Customer Number Bar Code Label here*

OR

☒ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
William H Drummond	20,590		
David G Duckworth	P-39,516		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number or Bar Code Label [ ] OR ☒ Correspondence address below

Name	Drummond & Duckworth				
Address	4590 MacArthur Boulevard, Suite 500				
Address					
City	Newport Beach	State	CA	ZIP	92660
Country	USA	Telephone	(714) 724-1255	Fax	(714) 724-1139

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
ALAN	BENN

Inventor's Signature	[signature]					Date	March 5th 2002
Residence: City	Maylands	State	Western Australia	Country	Australia	Citizenship	UK
Post Office Address	6 Warnes Street						
Post Office Address							
City	Maylands	State	Western Australia	ZIP	6051	Country	Australia

☐ Additional inventors are being named on the ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto